THE DIRECTOR OF
CENTRAL INTELLIGENCE

National Intelligence Council

22 March 1982

NOTE FOR:

FROM :

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You might want to pass this along to Mr. Lawson.

[redacted] 25X1

Central Intelligence Agency

Washington, D.C. 20505

16 MAR 1982

MEMORANDUM FOR: Mr. Lee Peters
Bureau of Oceans and International
Environmental and Scientific
Affairs
Department of State
Washington, D.C. 20520

SUBJECT: Assessment of PRC Hydroelectric Power Plans
and Technology [redacted] 25X1

The attached memorandum is in response to your request for an up-to-date assessment of current PRC hydroelectric development plans and technology. We hope this information will be useful to you and to the members of the PRC-Hydroelectric Exchange. [redacted] 25X1

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[redacted]

E. WAYNE BORING
Director
Scientific and Weapons Research

Attachment:
SW M 82-10016

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[redacted] 25X1

SUBJECT: Assessment of PRC Hydroelectric Power Plans and Technology [redacted] 25X1

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Central Intelligence Agency

Washington, D.C. 20505

DIRECTORATE OF INTELLIGENCE

10 March 1982

China: Technical Requirements for Hydroelectric Developments

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Summary

China has the world's largest hydroelectric generating potential, but only a small fraction of these resources have been developed. The Chinese government is seeking domestic development and exploitation of hydropower to account for 30% of the total national power production by the turn of the century in order to free other energy resources such as oil and coal for foreign exchange. While small and medium scale hydropower projects are at or near state-of-the-art quality, large projects will require significant foreign assistance. China lacks sufficient monetary resources and much of the sophisticated technology necessary for success in other than medium and small scale projects. China's severe shortage of electric power is a major obstacle to modernization. Without power, new factories cannot start up and existing factories cannot operate on a regular schedule. The Chinese estimate that 20 to 30 percent of their existing industrial capacity cannot be used because of power shortages. These are caused by poor planning and outmoded technologies in every aspect of power generation - from location and development of primary energy sources, through energy utilization in power stations, to the transmission of electricity. Operation of the Wuhan steel mill in Hebei has been adversely affected by such problems. Despite their ambitious plans for the mill, the Chinese discovered that the electricity in Hebei was insufficient to operate the plant at projected capacity.

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This memorandum was prepared by 25X1

Office of Scientific and Weapons Research, and coordinated with the Office of East Asian Analysis. Comments or questions may be directed to the Chief, Science and Technology Division, OSWR, extension

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The recent economic retrenchment has postponed many of China's plans for large hydroelectric projects. However, if funds become available through low cost loans, China will seek foreign assistance in its hydro design, construction, generation and transmission technologies. China in developing its abundant hydropower will reap ancillary benefits such as flood control, irrigation and water transport. Where hydroelectric power plants replace coal-fired ones, the railway system will be relieved from some of the burden of coal transport. As a world leader in exporting hydroelectric equipment, the US is especially interested in assisting China's hydropower development.

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Introduction

China's theoretical hydropower potential is 680,000 megawatts (MW). This is approximately three times that of the US. Of this potential, 380,000 MW is exploitable, making China one of the world's leading countries in water power resources. China has developed only 3 percent of this exploitable potential, however, and there are significant opportunities for future development. Currently hydroelectric power accounts for approximately 17 percent of China's electric power. By the year 2000, the Chinese hope to use hydropower for 30% of their electric power output. Most will be by indigenous development, with some foreign assistance. 25X1

China, with a very pressing need for electric power generation, must build dams, reservoirs, and power plants if it is to harness its major waterways, such as the Yellow and Yangtze Rivers. As a result of China's economic retrenchment, large scale hydroelectric projects such as Ertan, Datengxia, Longtan, and Three Gorges apparently will be postponed. Emphasis will be on small (less than 12 MW) and medium scale (less than 200 MW) projects. The only large dam in progress is the Gezhouba (2700 MW). 25X1

With more than 90,000 small dams, China is the world's leader in developing small scale hydroelectric power. These systems have been used to electrify small villages and towns and to power rural industries. The Chinese mini-hydro plants can be built with local labor and materials. As a result, China can meet local power needs without using scarce national funds and resources. Since 1960, China has been exporting small hydroelectric generating sets. China has begun construction, under UN auspices, of a Training Center for International Small-scale Hydroelectricity. This center will train technicians in hydro-electric construction, design, and survey as well as management personnel for hydropower stations in developing countries. 25X1

At present China is opting for the development of small and medium-scale hydroelectric plants because China has the resources and ability to construct them quickly with no need for foreign assistance and no need to tie-up large amounts of capital for long periods. But China has no choice but to construct huge dams if it plans to harness its biggest rivers such as the Yellow and Yangtze Rivers. 25X1

China needs foreign assistance on large (300 MW or above) turbine generators and long distance high voltage (500 kV)

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transmission equipment. China also needs foreign consulting services in engineering design and dam construction in order to speed up construction time and eliminate costly design errors. At this time, China does not have the monetary resources to build large scale dams unless it can obtain foreign financing at preferential rates, such as the 1500 MW Wuqiangxi project now financed by a Japanese loan. 25X1

In the near term, China will continue to acquire information, send its engineers overseas for training, obtain specific consulting services, and seek assistance in dam design and possibly also in planning multiple purpose projects. It will also continue buying advanced equipment such as microprocessors, computers, communication equipment, large generators and turbines, and heavy earthmoving trucks, which cannot be easily manufactured domestically. 25X1

Once China starts to build major hydroelectric projects such as Three Gorges, there will be significant opportunities for foreign companies that have dealt continuously with China. Besides providing professional services for design and construction projects, and supplying heavy construction equipment and advanced technical equipment, foreign companies may be invited to participate in joint development projects. 25X1

To be successful in trade with China, foreign companies will need to be familiar with Chinese trade habits and the specific technical, social, and cultural environment of China. Chinese standards of engineering practice are not necessarily the same as those of industrialized countries. A primary difference in China is that manual labor, which is cheaper and more readily accessible, is used more than mechanical equipment. An illustration is the project at Gezhouba where thousands of unskilled laborers were employed to quarry rocks by hand. Recent U.S. visitors to the hydroelectric development project at Liujiaxia on the Yellow River noted that the project is entirely Chinese in design, equipment, and construction. Liujiaxia illustrates a Chinese ability to mobilize human resources for important projects. 25X1

The following sections discuss China's technical capabilities and requirements for foreign assistance in construction, generation, and transmission of hydropower and the current status of foreign involvement in hydroelectric resources development. 25X1

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Construction

China has built 13,000 large dams in less than 30 years. It has accumulated experience in surveying, designing and building hydroelectric power stations. Of the ten big hydropower stations completed or under construction, six have dams over 100 meters high; the highest, at Wujiandu, reaches 165 m.

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The success or failure of any hydroelectric project depends on the crucial early phase survey and design work. Inadequate survey and design studies ultimately result in waste and problems. At some sites, landslides caused by large, poorly designed reservoirs have reached a magnitude of several hundred meters. The Chinese ability to analyze, predict, prevent, and control landslides is primitive. China also needs assistance in solving problems of dam structure vibration and water stream washout which could affect bank stability and cause abutment instability. Large computers are desirable to solve vibration problems for which the Chinese still rely on manual computation.

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Many large power stations in China will be built in active earthquake regions. Reservoir filling-induced earthquakes have already occurred near some Chinese hydroelectric power stations. To insure safety in high dam construction, indigenous research needs to be supplemented by advanced methods of numerical analysis from abroad. China lacks sufficient laboratories and computer facilities to investigate soil dynamics in earthquake regions.

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Because of the complex topographic conditions of China's good potential dam sites, Chinese dam designers need foreign assistance. In regions having large hydroelectric potential, high mountains and deep valleys make construction and transportation difficult. China still lacks the advanced technology to dig where there are serious fragmented tectonic belts and dredge where the river beds are covered by sand pebble layers over 100 meters thick. Engineering modeling methods are needed to find optimal techniques for digging, dredging, filling dams with concrete, using anchor steel reinforcements, and handling dam stress. Again the lack of good computer facilities has hampered China's attempts to use model tests and finite element methods to solve problems in rock stability. For example, the Chinese are investigating various spillway layouts at dam sites in narrow river valleys. They need advanced studies of spillway surface curvature to solve overflow problems of high arch dams and hydraulic problems in high waterhead overflow, such as analysis of turbulent boundary layer and gas admixture.

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To support the construction of large hydroelectric projects, China has recognized the need for multipurpose development plans which coordinate land acquisition, population resettlement in inundated territory, relocation of factory and mining enterprises, telecommunications and transport routes, and environmental protection.

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Foreign assistance will be needed in all phases of high dam construction. China's planned large scale hydroelectric projects such as those at Three Gorges, Ertan, and Longtan will all have dam heights over 200 meters. Because water pressure is so much greater at these high dams, their design and associated hydraulic equipment will require advanced engineering techniques. The highest existing dam in China is Liujiaxia, with a height of 147 meters. Other high-dam construction problems that will need foreign assistance include survey, design, and research work regarding the high flood levels at the dam sites, complex geological conditions, high water head, large flow and flood discharge, stream diversion during construction, large underground tunnel excavation for power houses, location of central control facilities, rock crushing for filled dams, waterproof dam materials, excavation, measures for minimizing the excavation required, and debris removal.

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Generation

Two 170 MW capacity domestically manufactured turbines have gone into operation at Gezhouba. These two low-head turbines were jointly manufactured by the Dongfang Power Equipment Plant and the No. 2 Heavy Machinery Plant in Sichuan Province. The two generators can produce more than 1.8 billion Kwh per year, the equivalent electricity generated by 1.8 million tons of coal or one-half million barrels of crude oil. With the expertise gained from operating these two 170 MW turbines, we expect that the Chinese will encounter no major problems in the nineteen 125 MW turbines to be installed at Gezhouba. However, to develop a 300 MW turbine and later the more ambitious 1000 MW turbine for the Three Gorges Project, the Chinese will have no choice but to seek foreign assistance.

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Corrosion of water turbines caused by cavitation is a serious problem affecting the turbine life expectancy. Current Chinese methods to solve the problem of cavitation in sandy water are either to install the turbine at a greater depth or to use a low speed hydraulic turbine. These methods will not be effective in large power stations. Instead China needs foreign assistance to develop proper erosion-resistant steel materials. It also needs foreign assistance to conduct model tests of hydraulic structures

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in cavitation tanks.

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China plans to computerize its power station control systems to improve operating efficiency. Microprocessors are needed for power station automation. Other computer-related items China needs to purchase abroad are peripheral interfaces, programable interval timers, interrupt controls and CRT controllers, digital input devices, and analog output devices.

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Transmission

In order to utilize its hydroelectric potential, China needs 500 kV alternating-current power transmission systems to efficiently transmit power to users over long distances and to allow the systems to carry increased power loads. The present transmission system of 110 kV, 220 kV, and 330 kV networks is inadequate to transmit power from the large dams.

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China's first 500 kV transmission network is the Pingwu line with a total length of 600 km and an initial power capacity of 500 MW. It supplies electricity to Henan and Hubei Provinces from the Yangtze River Gezhouba Hydropower Station. This network employs Japanese, French and Swedish 750-Mva single phase transformers, switches, inductors, relay protectors and control devices. It also uses domestically manufactured steel cables, porcelain insulators and other auxiliary devices. This line is not yet operational because large quantities of angle steel, bracing wires, conducting wires, and other materials have been stolen from a section in Hubei. Thus the Chinese have to find ways to protect their transmission equipment if they don't want to delay the progress of their electric network.

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The Chinese have also started to build their first domestically manufactured 500 kV transmission system in Inner Mongolia. Three other 500 kV transmission systems are being planned. China realizes that its major hydraulic resources are very far from the region of major loads. They require foreign assistance in ultra high power transmission manufacturing technologies capable of large capacity transmission (several million kW) over long distance (greater than 1500 km.)

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Foreign Assistance in Hydroelectric Resource Development

Foreign technology, financing, and project management are needed to develop China's hydroelectric resources. China is

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evaluating and comparing the skills, products, costs and financing methods offered by firms and government agencies of Australia, Austria, Belgium, Brazil, Canada, Denmark, West Germany, France, Japan, Italy, Norway, Sweden, Switzerland, United Kingdom, and the United States. China views financing at preferential rates for hydroelectric resources development as the first priority in its search for foreign assistance. So far the three major sources of development loans have been Japan, the United States, and the World Bank. 25X1

The 1500 MW Wuqiangxi Project is financed by a Japanese loan. Interest on this loan is three percent, with thirty years to repay plus a ten year grace period. Although the Japanese loan is nominally untied, Tokyo's financing of the Wuqiangxi project has reinforced Japan's leading position in the competition for contracts on the project. 25X1

Among the other foreign nations involved in China's hydro development, the United States is currently the country best qualified to challenge Japan's leading position because of the availability of US funding from the Trade and Development Program. Although countries like France, Germany, Italy, Canada and Brazil have the technological skills to challenge the United States and Japan, they have not offered loans comparable to those of Japan. 25X1

China's policymakers have clearly indicated that China has little interest in seeking foreign technical assistance in the 1980s unless foreign government funds are also available at acceptable interest rates. Sweden, Canada, and West Germany have provided free technical training for Chinese hydro engineers. If they can also provide attractive funding, China will most likely expand its sources of hydropower assistance by including these countries. So far only Japan is known to have offered feasibility study financing. Companies from Norway, West Germany, Brazil and others are still at the stage of negotiating for contracts but nothing definite has emerged. It is apparent that the bottleneck is due to financial considerations. 25X1

Besides assistance from Japan and the United States, the World Bank has emerged as an important source of funding for China's hydroelectric projects. Under the overall aegis of the World Bank, the US firm IEC has been selected to perform consulting services for the Lubuge Project on Hongshui River and the Shuikou Project in Fujian Province. Also the Australian firm Snowy Mountain has been selected by the World Bank to conduct a feasibility study of Lubuge. 25X1

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There is current evidence of China's continued interest in US technical assistance. As of February 1982, foreign assistance in tunneling technology and DC transmission systems will be needed in Tianshenqiao, an already approved project. China's Ministry of Electric Power Industry expressed the view that this may lead to a major project for US companies in the area of engineering design and construction, tunneling, and turbine generators if Export-Import Bank funding can be obtained. 25X1

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